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Operational gaming is a kind of decision simulation where the players make decisions within the framework of a simulated operating system. For the game to have value in developing vocational awareness, the decision-making exercise should be structured around a model of real life vocational decisions. The gaming experience aims toward helping the player clarify his own values pertient to the real world of work and to conceptualize kinds of decisions to be made. The elements of the game are players, goals, rules, and choices. The relationship between the elements and the sequencing of decisions are depicted by the model. The extent of the model (basic structure) depends on how much realism should be built in. Gaming by itself does not yield a maximum benefit but should be part of a total program which includes readings, lectures, the games, and critiques. (Author/KP)

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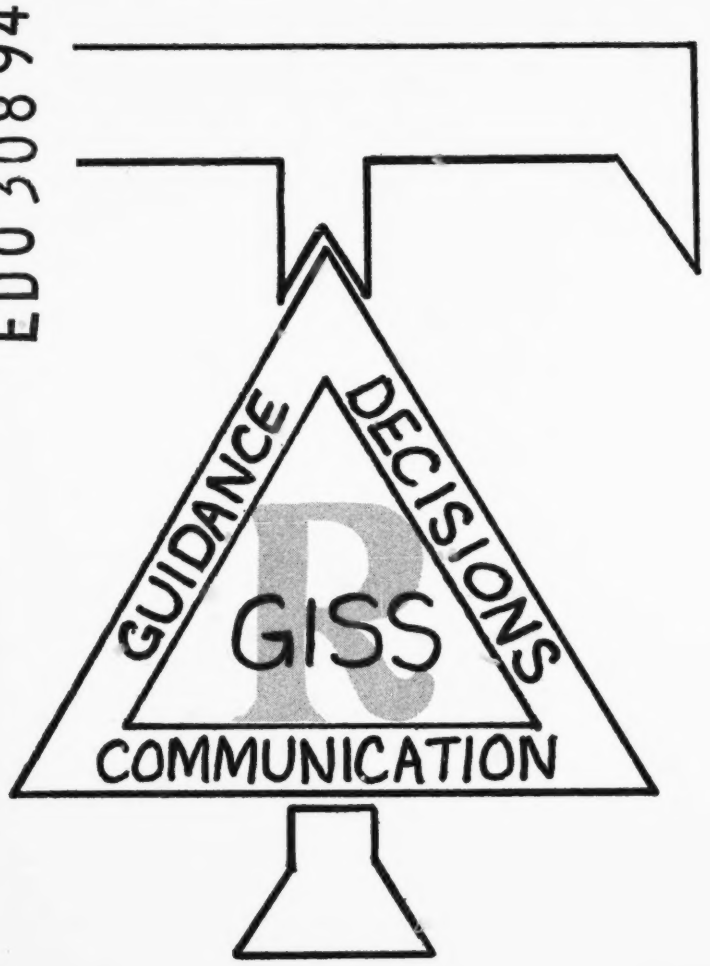

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OPERATIONAL GAMING FOR VOCATIONAL AWARENESS: A SURVEY

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OPERATIONAL GAMING FOR VOCATIONAL AWARENESS: A SURVEY

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The purpose of this paper is to discuss operational gaming as a result of reviewing the literature related to simulation, operational gaming, and game theory.

Throughout the literature the terms simulation and gaming are used interchangeably. However, game theory in conventional frames of reference . . . "bears little relationship to educational (operational) gaming (8, p.6)." Clarification of these terms seems very important if "educational (operational) gaming" is to take on meaning.

Simulation

Simulation is a term which refers to a class of analytical tools. Simulation is a:

"synthetic experiment (13, p.4)"

"technique of systems analysis (9, p.358)"

"analytical tool (14, p.vii)"

"experimental technique of an operating system (17, p.290)"

All simulations, as used here, involve the use of "models." Simulation is a "process" of analysis whereas the model is a tool used in this process.

The "process" of simulation includes (1) building a model that has the properties, in a simplified form, which the analyst thinks exist in the real world; (2) testing the model for its predictive validity; and (3) making predictions of the behavior of the system (as described by the model) at different levels of the variables and parameters.

Hare (9, p.6) delineates four approaches to simulation which are used alone or in various combinations:

1. Manual Simulation: The manipulation of scale models called iconic models or "look-alike" models since they duplicate the actual form of the real system being analyzed. An example is the wind-tunnel simulation of the flight characteristics of an aircraft.

2. Analogy Simulation: The use of a physical system which has the same mathematical properties as the system to be evaluated. The substitute (analogy) system is easier to build and manipulate. An example is the electric analogy of a mass accelerometer.

3. Symbolic Simulation: The reducation of the system to mathematical formula and symbolic logic. The manipulation of the approach is called the algorithm (a fixed step-by-step procedure). Symbolic simulation can be performed on the analog or digital computer. The system defined by a complex set of logical statements are best handled by the digital computer.

4. Operational Simulation: The use of simulation within operating environments in which human participants use their judgment and other human abilities to interact with the simulated environment. (As we will see later, operational gaming fits in this category.) This simulation approach evaluates responses of the experimental subjects and feeds back this information to the human participants. A series of these 'input and feedback' cycles constitute a simulation run during which the behavior of the system is analyzed.

Operational Gaming

" . . . a game is any situation in which one or more persons share the control of a set of variables and in which each must reach decisions relating to the activity of the whole group, with the "payoff" (reward) to each person determined not only by his own actions, but also by those of others in the group . . . The payoff is the settlement which a player receives at the termination of a game (6, p.561)."

Coleman (5, pp.69-72) discusses four types of games:

1. Parlor games: Primarily for entertainment but they also have educational value in that this is where the child first becomes to understand (1) the meaning of a rule, and (2) the rule must be obeyed by all players otherwise the game will not work.

2. War games: Simulations designed to teach logistic and strategic skills. The war game was one of the first ways that simulation and games were combined. War games date back to the "gladiators and jousting knights who used them to develop alternative tactics and strategies. Since the mid-seventeenth century, when a group of Prussian generals adapted chess for an exercise called the King's Game, games played on table tops have provided a respectable means for the study of war and maneuver (3, pp.62-3)."

3. Management games: Simulation designed to teach management decision making in complex business situations. The managements, or business, game was developed from war games. The first non-military game was devised by the American Management Association in 1957 (3, p.63).

4. Academic games: Simulations designed to teach individuals the concept of decision-making in complex society situations. Academic games were pioneered by Kalman J. Cohen at the Carnegie Institute of Technology as early as 1958 (3, p.63).

The relationship between simulation and gaming is now clear. The discussion above indicates that gaming involves an abstraction of some complex situation (model building), and the decision-making process. In fact, the kind of games referred to here can be considered "decision simulation (1, p.5)."

Thus, gaming is a special kind of simulation in which the participants are human decision-makers, and decisions are made within the framework of the system being simulated (14, p.205).

So far nothing has been said about operational gaming. "The term 'operational game' has come into use as a consequence of the employment of such techniques in operations evaluation (11, p.1)." The kind of operations evaluation that Kinkade and Kidd are referring to is " . . . the evaluation of processes, tactics, schedules, and other programmatic parameters for a wide range of industrial and military operations (11, p.1)." Naylor (14, p.3) uses the term in a broader sense:

> "The term 'operational gaming' refers to those simulations characterized by some form of conflict of interest among players or human decision makers within the framework of the simulated environment. "Players or decision makers act within the simulated environment, and the experimenter, by observing them, may be able to test hypotheses concerning the behavior of the individuals and/or the decision system as a whole' . . . The two most widely used forms of operational gaming are military games and business managements games. Military gaming is essentially a training device for military leaders which enables them to test the effects of alternate strategies under simulated war condition. Business games are also a type of educational tool but for training . . . managers or business executives . . ."

This broader use of the term includes the training function as well as the "special-purpose" function just mentioned. The meaning of operational gaming that will be assumed in this paper will be that of Naylor.

Notice that our assumed definition of operational gaming fits into Hare's classification of operational simulation (see above discussion of simulation). Thus, operational gaming appears to be a kind of operational simulation with an added dimension called interest conflict. A conflict of interest arises when " . . . an individual is in a situation from which one of several possible outcomes will result and with respect to which he has certain personal preferences (12, p.1)."

One final comparison between gaming and simulating is of interest. Shubik (15, p.736) makes this distinction: " . . . gaming usually (though not always) makes use of a simulated environment to study the behavior of, or to teach individuals, while simulation is directed towards studying the behavior of a system given the behavior of the individual units or vice versa. Gaming always involves the presence of decision-makers. Simulation does not necessarily entail the involvement of individuals. In most instances a simulation involves only the machine manipulation of a model."

Game Theory

Game theory " . . . is a branch of mathematics that aims to analyze various problems of conflict by abstracting common strategic features for study in theoretical models --- termed games because they are

patterned on actual games such as bridge and poker. By stressing strategic aspects (i.e., aspects controlled by the participants), it goes beyond the classical theory of probability, in which the treatment of games is limited by aspects of pure chance (19, p.1121)."

Game theory is an attempt to abstract the problems of interest conflict into a mathematical system. The approach has been to reduce the conflict problem to that of a simple optimization which can be handled by the calculus. " . . . it is worth emphasizing . . . that game theory is primarily a product of mathematicians and not of scientists from the empirical fields (12, p.3)."

Game theory is said to have begun with Emile Borel in 1921 and established by John von Neumann in 1928. Von Neumann and Oskar Morgenstern jointly developed game theory as a means of dealing with competitive economic behavior and in 1944 they published their work Theory of Games and Economic Behavior. Since this publication " . . . the literature in the field has mushroomed. The main developments have taken place in economics, statistics, mathematics, and military science. However, recently, publications both in sociology and political science have begun to appear (16, p.5)." The theory classifies games as (1) singular, dual, and plural, (2) extensive and normalized, and (3) finite or infinite.

Singular, Dual, and Plural Games. This classification refers to the number of active interests involved in the play and not necessarily the number of individuals. There may be one or more persons representing a single interest. Table I delineates this classification (19, p.1122).

TABLE I

pe	Number of Interests	Number of Participants	Characteristics	Example
ngle	One	One or More	a) Absence of conflict b) No opponent (except nature) c) Player need only list possible courses of action and select the best according to some utility measure.	a) Solitaire b) Puzzles c) Isolated economic units with a single goal (Robinson Crusoe)
ual	Two: Diametrically Opposed	Two or More	a) What one wins, the other loses (Zero-Sum). b) Each party seeks an optimum course of action. c) Must reckon with the possible actions of opponent.	a) Chess b) Two-handed card games, e.g., Cribbage c) Two-team games, e.g., Bridge
ural	Two or More: not Diametrically Opposed	Two or More	a) Non-co-operative solution: There is a pattern of independent action in which there is no incentive for deviation by any player alone. b) Co-operative solutions: The parties agree to maintain a coalition; each receive at least as much from the coalition as from independent action	a) Two competitive sellers in a market b) Two-party bargaining

Extensive and Normalized Forms. This classification refers to the rules of the game. " . . . the extensive forms amounts to a literal translation of the rules into technical terms of a formal system designed to describe all games (19, p.1122)." All features which refer specifically to the means of playing the game are eliminated. A systematic description of the game elements is made. Some of the elements are the (1) interrelations between the player's choices, (2) the variety and the character of the information available, and (3) the effect of chance on the play. The purpose of the description is to isolate the junctures at which the player must make a choice, and isolate the states of information on which the player's choices are based. "From this analysis emerges a precise definition of the first key concept on which the theory of games has been built. This is a notion of a pure strategy for a player; namely, a complete set of advance instructions that specifies a definite choice for every conceivable situation in which the player may be required to act. Such a set of instructions represents a total plan that covers all contingencies the player may face during any playing of the game, whether these are attributable to choices of other players or to events governed by chance; its execution could be delegated perfectly well to an agent without discretionary power (19, p.1122)." Game theory does not analyze many of the common parlor games because of this strict requirement of the pure strategy. The number of pure strategies of the game may be so enormous or a single pure strategy so complex that it does not yield to analysis.

The normalized form is a condensed version of the game. Luce and Raiffa (12, pp.5-6) characterize the normalized n-person game as follows:

1. There exists a well defined set of choices for each player.

2. Each player is required to make a choice which is made without any knowledge of the particular choice made by the other players.

3. Given the choices of each player, there is a certain outcome which has value to the player based on his own peculiar tastes and preferences.

4. The problem: Which choice should a player make in order that his partial influence over the outcome benefits him most? All other players are similarly motivated.

The difference between the extensive and normalized form appears to be in how the game is played. The extensive form is played with such a "complete set of advance instructions" that the players need not be present during the play (they can "delegate the execution" to an agent such as the computer), whereas the normalized game is played with the "decision-makers" present making choices of over-all strategies.

Finite and Infinite Games. The game is classified finite if the number of alternatives in a pure strategy and the number of strategies in the game is finite.

Conversely, the game is infinite if the number of pure strategies is infinite. An infinite game can arise from a finite game which has

its full range of strategies replaced by a continuum of numbers. This is done when the game is too complicated to handle in its original form (19, p.1122).

The factor which distinguishes game theory from operational gaming is the concept of pure strategy. Both the extensive and normal forms of game theory require a "well defined set of choices for each player." Operational gaming does not require this. Operational gaming is a heuristic teaching device. Operational gaming ". . . teaches by putting the student in an environment and making him respond to its demands. By doing so, the student discovers for himself the results of his actions and is led to abstract the fundamental relationship present in the situation (10, p.242)." In the operational game situation, the player does not know enough about himself or his environment in order to determine the total plan required by the pure strategy -- he is in the game situation to learn what these might be. Operational gaming, however, does correspond to the remainder of the characteristics of the normalized form described above.

Gaming for Guidance

The main theme of this paper is to establish operational gaming as a tool for vocational awareness. Needless to say, vocational awareness involves occupational choice which, in turn, involves the decision-making process. In fact, the entire process of guidance and the process of decision-making is "intimately interwoven." Gelatt and

Varenhorst (7, p.88) suggest that a guidance program should be built on a "decision-making foundation" which would provide a system for the program.

> "This is the rationale behind the guidance program being developed in the Palo Alto Unified School District. It was first conceived of as a group guidance approach to teaching decision-making through use of data collected on Palo Alto students. Now it has been expanded and enlarged to include all guidance activities (7, p.89)."

Imbedded in Palo Alto's guidance program is the application of operational gaming as a tool in value clarification.

> "The counseling problem at hand may consist principally of helping the individual to clarify his own values, rather than simply accept in their entirety the values of a group or society. An example of this is the decision to go to college, since society now places a high premium on this alternative at the time of high school graduation. This social pressure is very evident among the students in Palo Alto, and a major guidance task is to get students to consider other alternatives if appropriate (7, p.92)."

The game used for this purpose is a career game, viz., "Life Career Game" developed by Sarane Boocock of the Johns Hopkins University. This game simulates decision-making by allowing the "players" to plan the life of a hypothetical individual as he goes thru life making decisions about education, jobs, marriage, etc.

The game is played by teams of two to four members. Any number of teams can participate. Each team is given a case history, in profile form, of a ficticious person. This person is usually a student about the age of the players.

The game is organized into 10-12 rounds, each representing one year in the life of the hypothetical person. Each year is a decision

period where the players plan a schedule of activities for a typical week, allocating time for a job, school, family responsibilities, and leisure. The person cannot be involved in all available activities, thus a conflict of interest arises when the team attempts to choose a combination of alternatives (activities) which will hopefully maximize his personal satisfaction. Each round is scored in the four areas of education, occupation, family life, and leisure. The outcome in each area is based on a set of tables consisting of U.S. Census, other survey data, and spinners and dice. The tables show the probabilities of certain events given the person's profile, and the spinners and dice introduce chance factor. The team with the highest total score at the end of the game wins.

Some of the activities, such as job entry and college entry, require formal application blanks to be completed. This is considered an important integral feature of the Life Career Game since the students, as players, attain these skills in a learning environment (2, p.220).

Tiedeman (18, pp.53-5) in his project ISVD (Information System for Vocational Guidance), also uses operational gaming as a "practice in decision-making." The game used in ISVD is a modification of the Life Career Game discussed above. The student is introduced to the game via a film which expedites the use of the game by new players. The introductory film is followed by a practice round where the player makes decisions and the practice round is scored. Both the introductory film and the practice round can be bypassed by the experienced player.

The actual play of the game is supervised by a computer program called MONITOR. MONITOR traces the player's actions and performance, and accumulates the scores. At the end of a game session (one or more rounds), MONITOR summarizes the results and provides a comparison of scores of prior sessions. Data files on education, occupation, and leisure activities are stored in the computer system and can be accessed by the player through a remote terminal keyboard at will. A weekly schedule blank and a cumulative record blank is displayed on a CRT and its content is changed by the player or the system during the play. An adjunct to the regular game resources is the ability to select and view on slides the rules of the game and the profile of the "person."

A properly prepared and administered game has several advantages as a method of learning at the concept level. It involves the learner in the decision-making process, in which the learner is forced to declare values and to examine them closely, gets practice in decision-making, is able to try alternatives without serious setbacks resulting from poor choices, is introduced to the information sources needed to determine the alternatives, and begins to learn how to ask questions pertinent to decision-making data (7, p.93).

Coleman (4, p.70) gives several arguments in support of operational gaming: (1) Players learn concepts relevant to the game, (2) "the structure (of the game) selectively abstracts a single process . . .," (3) the game constrains behavior and provides a natural screening device for information selection, (4) the discussion session

which follows the game reinforces the learning experience, and (5) the very same game can be used by persons with wide varieties of background and training. " . . . games may be regarded as a special invention in which children or adults practice the components of life itself, a kind of play within the larger play of life (4, p.63)."

Operational gaming in the classroom is said to be a response to the challenge of a complex society which require a higher degree of abstract intellectual learning. This challenge can be met if the games ". . . force the development of approaches the learning in school that more nearly approximate the natural processes through which learning occurs outside school (5, p.70)." Operational gaming is goal oriented and its nature provides a special kind of motivation for learning since they " . . . tend to focus attention more effectively than other teaching devices, partly because they involve the student actively rather than passively (5, p.69)."

Operational gaming for vocational awareness is also a response to a challenge. Project TGISS proposes that there is a lack of adequate conceptualization concerning the kinds of decisions facing students who are preparing themselves for the world of work, and a lack of adequate conceptualization of counselor role relevant to the student decision making process. For the student, the game provides the structure for action required for making "intelligent" social decisions. The game selects certain "components of life" and defines their relationship with one another with the purpose of formally structuring the individual's decision-making thought processes. For the counselor,

the game provides clarification of his role as a teacher of the decision making process as well as a manager of information retrieval and analysis.

As a conclusion to this section, the following definition of operational gaming is proposed: An operational game is a sequential decision-making exercise structured around a model of a real life situation in which participants assume the role of managing the simulated operation.

Game Design

The game is built around certain characteristics which are:

1. The basic elements are; players, goals, rules, and choices. The relationship of these elements are specified in the simulation model;
2. The number of players is limited;
3. The number and nature of a choice is limited as specified by the model;
4. The choices take place in a sequence specified by the model;
5. The specific model design delimits time and the extensivity of ordinary activities of behavior (8, p.62).

The overall approach to the game design is:

1. Define the guidance objectives;
2. Collect the data needed to determine the game structure;
3. Determine the general characteristics of the game;
4. Quantify certain elements, rules, and relationships;

5. Determine the mechanics of the play;

6. Validate the game prior to the educational play (8, p.119).

The objectives of the game must be relevant to the guidance concept to be taught. These objectives might be to (1) teach a specific decision rule about the world of work, (2) induce attitudinal changes and insight to the decision-making process, and (3) provide integrative decision-making experience through exposure to several aspects of a total environment.

The basic structure of the game depends on how much realism and complexity should be built in, and what specific rules, elements, and relationships should be included. The rules of the game are either substantive which defines the nature and scope of the decision making, or procedural which defines the mechanical aspects of the decision making. There are three kinds of elements which includes: Input elements or the decisions made by the players; Output elements or the results of the game; and, Informational elements which is any source information made available to the players such as the rules and the environmental data. The relationships are either determining, limiting, or indirect. A determining relationship is the type where the value of one element will determine the value of other elements. A limiting relationship defines how the value of one element is limited by the value of others. The indirect relationship neither determines or limits values but is there merely to complete the simulation structure (8, pp.72-119).

Maximum benefits are derived when the game is interwoven with group counseling sessions supplemented by selected readings, lectures, and critique. The lectures and selected readings should provide the foundations of the decision making process and techniques for data collection. The critique, a necessity for most of the players, can provide a second learning experience.

We should not leave the subject of gaming without discussing some of the problems of its design and implementation. Designing the game is actually quite difficult. In order for the game to simulate the effects of student decisions properly, the designer must know how these decisions really affect the total environment. This, unfortunately, is something no one really knows. The best we can do is extract certain known relationships from the total environment, those relevant to the objectives, to teach a certain concept.

Also, the introduction of the game into the learning environment is no simple matter. " . . . the imagination needed to introduce the gaming technique into the school systems is as great as that required to design the games themselves (1, p.122)." The reason for these difficulties arise because " . . . games are built upon a number of assumptions that run counter to traditional notions of teaching (1, p.94)," A summary of these notions are:

1. Physical format: During the game the classroom is often very noisy and seemingly less well organized than the conventional lecture-recitation session.

2. Teacher-student relatipnship: The students can be autonomous, self-motivating, and self regulating with regard to their own learning.

3. Type of intellectual problem: The game presents a complex problem with usually more than one winning strategy. Contrast this with the textbook problem which usually has only one solution.

4. Games present the world as it is and not what it should be.

Summary

To summarize, operational gaming is a kind of decision simulation where the players are human decision-makers. The players are called upon to make decisions within the framework of a simulated operating system. In order for the game to have value as a tool for developing vocational awareness, the decision-making exercise would be structured around a model of real life vocational decisions. The result of the gaming experience would be to help the player clarify his own values pertinent to the activities of the real world of work; also, to provide a conceptualization of the kinds of decisions to be made in the world of work.

The elements of the game are players, goals, rules, and choices. The relationship between the elements and the sequencing of decisions are depicted by the model. The extent of the model (basic structure) depends on how much realism should be built in.

Gaming by itself does not yield a maximum benefit. Operational gaming should be only a part of a total program consisting of readings, lectures, the games, critiques, etc.

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